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NASA TECH BRIEF

Goddard Space Flight Center

Amplitude-Steered, Pseudophased Antenna Array

The problem:

If a suitable number of antenna elements are included in a ring array, the element spacing can be made such that when a small fraction or segment of the total number of elements is excited with an appropriate phase distribution, a directional beam of correct shape will result. To scan the beam, antenna elements are sequentially switched into the driven segment as elements at the other end of the driven segment are switched out. Thus, the driven segment advances around the periphery of the ring array.

In actual practice, as elements are incrementally added at one end of the driven segment and removed at the other end the resultant beam is unchanged, but the incremental switching introduces signal phase discontinuities into the communication link. If a phase-modulated signal structure is being employed, these discontinuities can have a serious effect on link stability and performance. In fact, phase lock can be lost for an appreciable fraction of time.

The solution:

By gradually transferring power from the receding element in the driven segment to the element next to the leading edge of the driven segment, and by accomplishing antenna element switching during those intervals when no power is being applied to the elements being switched, the beam may be smoothly scanned around the ring array without instantaneous phase transitions while maintaining constant radiated power.

How it's done:

Figure 1 is a block diagram of a four-channel system used to control power and antenna element switching. The transmitter source sends signal energy to a four-way power divider which energizes a group of four power amplifiers. Each amplifier supplies 5 W for a combined output of 20 W. Considering only the

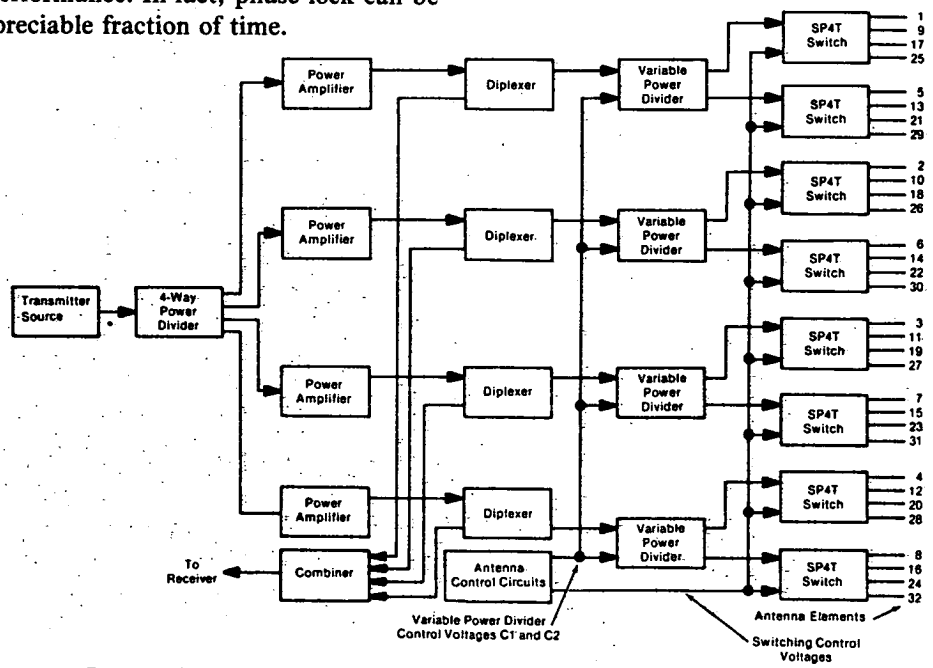

Figure 1. Block Diagram: Antenna Element Switching and Power Control System

(continued overleaf)

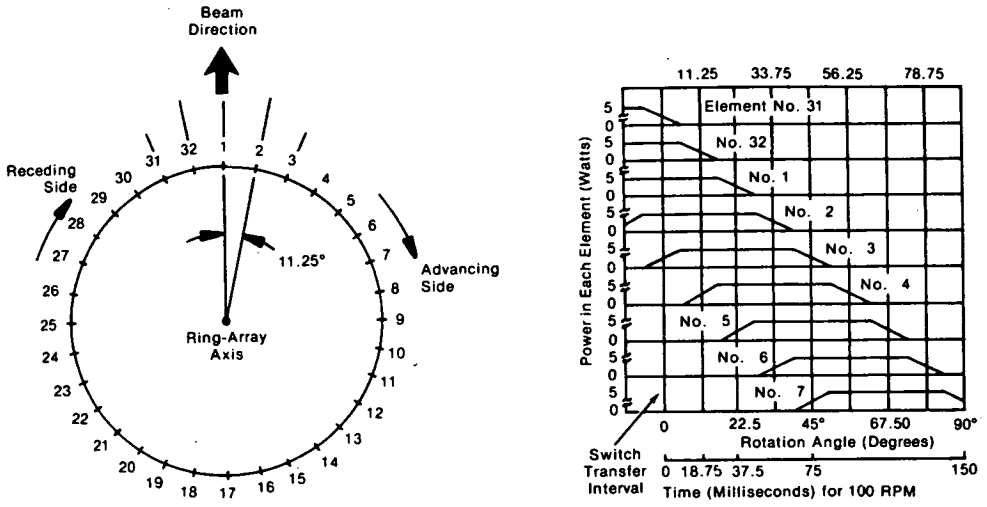

Figure 2. Ring Array and Timing Diagram

uppermost channel, the amplifier applies its output through a diplexer to a variable power divider. Depending on the control voltage applied by the antenna control circuits, the variable power divider will supply the output power to one or both of two single-pole, four-throw (SP4T) switches. In operation it will gradually transfer the power from one switch to the other.

The first SP4T switch controls antenna elements 1, 9, 17, and 25 (see Figure 2), while the second switches elements 5, 13, 21, and 29. The other switches switch the remaining elements as shown. Thus the 32 antenna elements are switched by eight SP4T switches, which are operated in pairs by four variable power dividers, each of which operates at a constant input power level. The switching and power divider functions are all generated and controlled by the conventionally designed antenna control circuits.

Figure 2 shows the relationship of the 32 antenna elements located around the periphery of the ring array. The antenna element switching sequence is in a clockwise direction. For the beam direction shown, elements 32, 1, and 2 each receive 5 W while elements 31 and 3 receive 2.5 W each to produce a 20-W system. The antenna element spacing around the ring is adjusted so that this power distribution produces the desired antenna pattern. The antenna gain and beam width are optimized to illuminate the receiver with a high-gain pattern. Initially the power distribution between elements 31 and 3 is shifted. The 5-W input is maintained, while the power to 3 is increased and the power to 31 is decreased. When element 3 reaches 5 W and element 31 reaches zero, the power applied to element 32 is decreased as the power to element 4 is increased.

The ring array functions equally well as a receiving antenna, since the SP4T switches and variable power dividers are reciprocal devices. It is only necessary that the transmit and receive functions be separated slightly in frequency to permit diplexing. The diplexers are included in the switching control system.

Note:

Requests for further information may be directed to:

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Patent status:

This invention has been patented by NASA (U.S. Patent No. 3,806,932). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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